PHY 251 equation sheet for exam 1

$\nu = \frac{\nu_0}{\gamma[1+(v/c)\cos\theta]}$ with $\theta = 0$ for emitter moving directly away.

$\gamma = \frac{1}{\sqrt{1-v^2/c^2}}$

$p = \gamma m_0 v$, $F_\perp = \gamma m_0 a$, $F_\parallel = \gamma^3 m_0 a$.

$$\begin{aligned} x_2 &= \gamma\left(x_1 - vt_1\right) \\ y_2 &= y_1 \\ z_2 &= z_1 \\ t_2 &= \gamma\left(t_1 - \frac{v}{c^2}x_1\right) \end{aligned}$$

and

$$\begin{aligned} v_{2,x} &= \frac{v_{1,x} - v}{1 - \frac{v\,v_{1,x}}{c^2}} \\ v_{2,y} &= \frac{v_{1,y}}{\gamma\left[1 - \frac{v\,v_{1,x}}{c^2}\right]} \\ v_{2,z} &= \frac{v_{1,z}}{\gamma\left[1 - \frac{v\,v_{1,x}}{c^2}\right]} \end{aligned}$$

$E = E_0 + E_k = m_0c^2 + (\gamma - 1)m_0c^2$,
$E^2 = E_0^2 + p^2c^2$.

$$\begin{aligned} p_{x,2} &= \gamma\left(p_{x,1} - v(E/c^2)\right) \\ p_{y,2} &= p_{y,1} \\ p_{z,2} &= p_{z,1} \\ E_2 &= \gamma(E - vp_x). \end{aligned}$$

$E = h\nu = hc/\lambda$, 1 eV=1.602×10^{-19} Joule, $h = 6.62\times10^{-34}$ J·sec, $h = 4.14\times10^{-15}$ eV·sec. $hc = 1239.8$ eV·nm. $k_B = 1.38\times10^{-23}$ J/K, $k_B = 8.62\times10^{-5}$ eV/K, $c = 3.00\times10^8$ m/sec.

$$\begin{aligned} u_\nu\,d\nu &= \frac{8\pi h\nu^3}{c^3}\frac{1}{\exp[h\nu/kT]-1}\,d\nu \\ \lambda_{\text{peak}} &= hc/(2.821\,k_BT) \end{aligned}$$

$E_k = h\nu - \phi$.
$\lambda = h/p$, $\lambda_s - \lambda_0 = \frac{h}{m_ec}(1-\cos\theta)$.

Centripetal force to maintain circular motion: $\gamma mv^2/r$.
Lorentz force: $q\vec{v}\times\vec{B}$.
Masses:

	kg	MeV/c^2	amu
m_e	9.11×10^{-31}	0.510999	0.000549
m_p	1.673×10^{-27}	938.272	1.007276
m_n	1.675×10^{-27}	939.566	1.008665
amu	1.660×10^{-27}	931.494	1

$p = h/\lambda$

$r_n = \frac{n^2}{Z}a_0$ with $a_0 = \frac{\epsilon_0h^2}{m\pi e^2} = 0.053$ nm.

$E_n = -\frac{Z^2}{n^2}E_0$ with $E_0 = \frac{me^4}{8\epsilon_0^2h^2} = 13.60$ eV.

$m_r = \frac{m_1m_2}{m_1+m_2}$.

$\frac{1}{4\pi\epsilon_0}\frac{Ze^2}{r^2} = m\frac{v^2}{r}$.

$\epsilon_0 = 8.85\times10^{-12}$ in mks units.

$(1+x)^n \simeq 1 + nx$ for $x \ll 1$.